

CLAIMS

[1] An imaging device operable to output an image of an object as an electrical image signal, comprising:

a solid-state imaging sensor including pixels which are two dimensionally arranged on a first flat surface and each of which has a photo-electric conversion function; and

a lens array including micro lenses two dimensionally arranged on a second flat surface separately provided so as to be parallel to the first flat surface, wherein

the solid-state imaging sensor includes imaging areas of unit including a plurality of the pixels,

each of the micro lenses forms an optical image of the object on a corresponding imaging area of unit, and,

a following expression (1) is satisfied for a pixel, from among the pixels included in the imaging area of unit corresponding to each of the micro lenses, positioned farthest from an optical axis of a corresponding micro lens:

$$\arctan(L/f) \leq \theta \quad (1),$$

where

θ is a maximum angle of an incident light capable of entering a pixel,

f is a focal length of a micro lens, and

L is a diameter of a circle circumscribing an imaging area of unit corresponding to one of the micro lenses.

[2] The imaging device according to claim 1, wherein
each of the pixels has a pixel lens on a light incidence
side thereof, and,

instead of the following expression (1), a following
5 expression (2) is satisfied for the pixel, from among the pixels
included in the imaging area of unit corresponding to each of the
micro lenses, positioned farthest from the optical axis of the
corresponding micro lens:

$$\arctan(L/f) \leq \arcsin NA \quad (2),$$

10 where

NA is a numerical aperture of a pixel lens.

[3] The imaging device according to claim 1, wherein
each of the pixels has a pixel lens on a light incidence
15 side thereof, and

at least one of the pixel lenses is positioned such that
an optical axis thereof is displaced from a center of a
photo-electric conversion portion of a corresponding pixel.

20 [4] The imaging device according to claim 3, wherein,
instead of the following expression (1), a following
expression (3) is satisfied for the pixel, from among the pixels
included in the imaging area of unit corresponding to each of the
micro lenses, positioned farthest from the optical axis of the
25 corresponding micro lens:

$$\arctan(L/f) - \varphi \leq \arcsin NA \quad (3),$$

where

NA is a numerical aperture of a pixel lens, and

φ is an angle formed between a normal line of the first
 5 flat surface and a straight line connecting an apex on a light
 incidence side of a pixel lens and a center of an imaging area
 of unit.

[5] The imaging device according to claim 3, wherein the
 10 pixel lens is positioned such that the optical axis thereof is
 displaced in a direction toward an optical axis of a corresponding
 micro lens with respect to the center of the photo-electric
 conversion portion of the corresponding pixel.

15 [6] The imaging device according to claim 3, wherein an
 amount of displacement of the optical axis of the pixel lens with
 respect to the center of the photo-electric conversion portion
 of the corresponding pixel increases as the distance from an optical
 axis of a corresponding micro lens increases.

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[7] The imaging device according to claim 3, wherein an
 output signal from each of the pixels included in an imaging area
 of unit is compensated by using a compensation coefficient set
 in advance according to the distance between an optical axis of
 25 a corresponding micro lens and each of the pixels.

[8] The imaging device according to claim 1, wherein the solid-state imaging sensor is a CCD.

5 [9] The imaging device according to claim 1, wherein the solid-state imaging sensor is a CMOS.